



## CHEM 3110: Organic Chemistry II

2023 Summer Session	
<b>Total Class Sessions: 25</b> <b>Class Sessions Per Week: 5</b> <b>Total Weeks: 5</b> <b>Class Session Length (Minutes): 145</b> <b>Credit Hours: 4</b>	<b>Instructor: Staff</b> <b>Classroom: TBA</b> <b>Office Hours: TBA</b> <b>Language: English</b>

### **Course Description:**

As a continuation of organic chemistry I, this course will focus on a description of carbonyl chemistry, the reactions and reaction mechanisms of carboxylic acid and its derivatives. The reactions of ketones, aldehydes and benzenes will be introduced and discussed. In addition, student will learn about mass spectrometry, infrared and UV/Vis spectroscopy, with an emphasis on NMR Spectroscopy and its application in structure determination. Topics also include carbohydrates, amino acids, peptides, and proteins, synthetic polymers.

### **Course Materials:**

Organic Chemistry, 8th Edition, Paula Y. Bruice (Author)

Publisher: Pearson Education

Language: English

ISBN 10: 0-13-404228-X

ISBN-13: 9780134042282

### **Course Format and Requirements:**

Material involves taking time to think things through, develop the knowledge (or process) and practice this. It is also very helpful to test yourself on your knowledge development. Using the quiz or exam as a means to test if you have learned something could be too late to determine you still have a gap in knowledge. Remember, lecture is very important in seeing process and models and hearing concepts and their derivation and application BUT is not the beginning and end of learning. It would be unusual to learn something simply from sitting in lecture.

Participation is not graded. However, participation is highly valued and to encourage participation this course has the following policy. A student's grade can be increased if he or she is at the margin and does have been active in class discussions. Such grade increases due to participation are not negotiable.

### **Course Assignments:**

<b>Quizzes</b>
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There will be 5 quizzes administered through the whole semester. Quizzes will always be completed in the first ten minutes of class. There will be no make-up quizzes.

### **Midterm Exam**

The two midterm exams will be based on concepts covered in class. It will be in-class, close-book and non-cumulative. No alternate arrangements will be made.

### **Final Exam**

The final will be cumulative and close-book. Note that the final will not be taken during the normal class times. Exact time and location for final will be announced later.

Note: All exams and quizzes are closed-books. Cheat sheets are not allowed. The only device allowed in quizzes and exams is a calculator. No other device (e.g. laptop or cell phone) is allowed.

### **Course Assessment:**

Quizzes	15%
Midterm Exam 1	25%
Midterm Exam 2	25%
Final Exam	35%
<b>Total</b>	<b>100%</b>

### **Grading Scale (percentage):**

A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
98-	93-	90-	88-	83-	80-	78-	73-	70-	68-	63-	60-	<60
100	97	92	89	87	82	79	77	72	69	67	62	

### **Academic Integrity:**

Students are encouraged to study together, and to discuss lecture topics with one another, but all other work should be completed independently.

Students are expected to adhere to the standards of academic honesty and integrity that are described in the Chengdu University of Technology's *Academic Conduct Code*. Any work suspected of violating the standards of the *Academic Conduct Code* will be reported to the Dean's Office. Penalties for violating the *Academic Conduct Code* may include dismissal from the program. All students have an individual responsibility to know and understand the provisions of the *Academic Conduct Code*.

### **Special Needs or Assistance:**

Please contact the Administrative Office immediately if you have a learning disability, a medical issue, or any other type of problem that prevents professors from seeing you have learned the



course material. Our goal is to help you learn, not to penalize you for issues which mask your learning.

### **Course Schedule:**

Class 1:

Syllabus + Course Overview

Mass Spectrum and Fragmentation

Calculate the Molecular Formula by Using the  $m/z$  Value of the Molecular Ion

Isotopes in Mass Spectrometry

The Fragmentation Patterns of Functional Groups

Other Ionization Methods

Gas Chromatography

Spectroscopy and the Electromagnetic Spectrum

#### **Chapter 13**

Class 2:

Characteristic Infrared Absorption Bands

Absorption Bands: Intensity and Position

Electron Delocalization and Hydrogen Bonding

C-H Absorption Bands

The Absence of Absorption Bands

Interpreting an Infrared Spectrum

The Beer-Lambert Law

The Visible Spectrum and Color

Use of UV/Vis spectroscopy

#### **Chapter 14**

Class 3:

#### **Quiz 1**

Fourier Transform NMR

Shielding

The Number of Signals in an  $^1\text{H}$  NMR spectrum

The Chemical Shift

The Relative Positions of  $^1\text{H}$  NMR Signals

The Characteristic Value of Chemical Shifts

Diamagnetic Anisotropy

#### **Chapter 14**

Class 4:

The Integration of NMR Signals

$N + 1$  Rule



Splitting

$^1\text{H}$  NMR spectra

Coupling Constant

Splitting Diagram

Enantiotopic and Diastereotopic Hydrogens

The Time Dependence of NMR Spectroscopy

$^{13}\text{C}$  NMR spectrum and DEPT  $^{13}\text{C}$  NMR spectrum

**Chapter 14**

Class 5:

Protons Bonded to Oxygen and Nitrogen

Deuterium

Resolution of  $^1\text{H}$  NMR Spectra

2-D NMR spectroscopy

Magnetic Resonance Imaging (MRI)

X-ray crystallography

**Chapter 14**

Class 6:

**Quiz 2**

Nomenclature

Structures

The Physical Properties of Carbonyl Compounds

Reactivity and Relative Reactivities

**Chapter 15**

Class 7:

Reactions of Acyl Chlorides

Reaction of Esters

Acid-Catalyzed Ester Hydrolysis and Transesterification

Hydroxide-Ion-Promoted Ester Hydrolysis

Reactions of Carboxylic Acids

**Chapter 15**

Class 8:

Reactions of Amides

Acid-Catalyzed Amide Hydrolysis and Alcoholysis

Hydroxide-Ion-Promoted Hydrolysis of Amides

Hydrolysis of Amides

Nitriles

Acid Anhydrides

Dicarboxylic Acids



How Chemists and Cells Activate Carboxylic Acids

**Chapter 15**

Class 9:

**Quiz 3**

Nomenclature

The Relative Reactivities of Carbonyl Compounds

How Aldehydes and Ketones React

Reactions of Carbonyl Compounds with Carbon Nucleophiles and Hydride Ion

**Chapter 16**

Class 10:

Reduction Reactions

Chemoselective Reactions

Reactions of Aldehydes and Ketones with Nitrogen Nucleophiles

Reactions of Aldehydes and Ketones with Oxygen Nucleophiles

**Chapter 16**

Class 11:

Protecting Groups

Reactions of Aldehydes and Ketones with Sulfur Nucleophiles

Reactions of Aldehydes and Ketones with a Peroxyacid

Witting Reaction

**Chapter 16**

Class 12:

Disconnections, Synthons, and Synthetic Equivalents

Nucleophilic Addition to  $\alpha,\beta$ -Unsaturated Aldehydes and Ketones

Nucleophilic Addition to  $\alpha,\beta$ -Unsaturated Carboxylic Acid Derivatives

Conjugate Addition Reactions in Biological Systems

**Chapter 16**

Class 13:

**Midterm 1**

Class 14:

Acidity of an  $\alpha$ -Carbon

Keto-Enol Tautomers

Keto-Enol Interconversion

Halogenation of the  $\alpha$ -Carbon of Aldehydes and Ketones

Halogenation of the  $\alpha$ -Carbon of Carboxylic Acid

Enolate Ion



Alkylating the  $\alpha$ -Carbon

Alkylating and Acylating the  $\alpha$ -Carbon via an Enamine Intermediate

**Chapter 17**

Class 15:

Alkylating the  $\beta$ -Carbon

An Aldol Addition Forms a  $\beta$ -Hydroxyaldehyde or a  $\beta$ -Hydroxyketone

The Dehydration of Aldol Addition Products Forms  $\alpha,\beta$ -Unsaturated Aldehydes and Ketones

A Crossed Aldol Addition

A Claisen Condensation is a  $\beta$ -keto Ester

Other Crossed Condensations

Intramolecular Condensations and Intramolecular Aldol Additions

The Robinson Annulation

**Chapter 17**

Class 16:

Malonic Ester Synthesis

Acetoacetic Ester Synthesis

Carbon-Carbon Bonds

Reactions at the  $\alpha$ -Carbon in living systems

**Chapter 17**

Class 17:

**Quiz 4**

Nomenclature of Monosubstituted Benzenes

The General Mechanism for Electrophilic Aromatic Substitution Reactions

Halogenation of Benzene

Nitration of Benzene

Sulfonation of Benzene

**Chapter 18**

Class 18:

Friedel–Crafts Acylation and Alkylation of Benzene

Friedel–Crafts Alkylation of Benzene and Alkylation of Benzene by Acylation-Reduction

Substitution and Elimination Reactions

Oxidation and Reduction Reactions

**Chapter 18**

Class 19:

The Nomenclature of Disubstituted Benzenes and Polysubstituted Benzenes

The Effect of Substituents on Reactivity and the effect of Orientation

The Ortho-Para Ratio



Additional Consideration

**Chapter 18**

Class 20:

The Synthesis of Monosubstituted Benzenes, Disubstituted Benzenes and Trisubstituted Arenediazonium Salts

Azobenzene

Nitrosonium Ion

Nucleophilic Aromatic Substitution

The Synthesis of Cyclic Compounds

**Chapter 18**

Class 21:

**Midterm 2**

Class 22:

Classifying Carbohydrates

The D and L Notation

The Configurations of Aldoses and Ketoses

The Reactions of Monosaccharides and Oxidation-Reduction Reaction of Monosaccharides

Kiliani–Fischer synthesis

The Wohl Degradation and The Fisher Proof

Monosaccharides from Cyclic Hemiacetals

Glucose and Glycosides

The Anomeric Effect

Reducing and Nonreducing Sugars

Disaccharides

Polysaccharides

Carbohydrates on Cell Surfaces

**Chapter 20**

Class 23:

The Nomenclature of Amino Acids

The Configuration of Amino Acids

Acid-Base Properties of Amino Acids

The Isoelectric Point

Synthesis of Amino Acids

Resolution of Racemic Mixtures of Amino Acids

Peptide Bonds and Disulfide Bonds

N-Protection and C-Activation

**Chapter 21**



Class 24:

**Quiz 5**

Protein Structure

How to Determine the Primary Structure of a Polypeptide or a Protein

Secondary Structure

Tertiary Structure

Quaternary Structure

Denaturation

**Chapter 21**

Class 25:

Chain-Growth Polymers

Radical Polymerization

Cationic Polymerization

Anionic Polymerization

Ring-Opening Polymerizations

Stereochemistry of Polymerization • Ziegler–Natta Catalysts

Polymerization of Dienes

Copolymers

Step-Growth Polymers

Physical Properties of Polymers

**Chapter 27**

**Final Exam (Cumulative): TBA**